The Potential Economic Impact of Nevada's Renewable Energy Resources

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Executive Summary

Rolling blackouts in California and rising energy prices have spurred renewed interest in renewable energy sources, such as wind, geothermal, biomass, and solar power for electricity production, home heating, and home cooling. Alternatives to nonrenewable energy sources such as coal, nuclear fission, and natural gas have many advantages in terms of reducing global carbon dioxide which leads to global warming, air-quality improvements, and other potential environmental and health benefits. Until recently, the market price of nonrenewable energy was low enough that converting to renewable sources did not have clear economic advantages. However, falling costs of electricity generation from renewable sources and rising energy costs for conventional sources are setting the stage for developing some of our renewable resources.

In 2003, Nevada's electricity consumption is expected to total nearly 36,000 gigawatts hours (gWh). Consumption growth rates are predicted to average 1.3 to 1.5 percent in northern Nevada and approximately 3 percent in southern Nevada. In part due to population growth in excess of energy infrastructure investment, Nevada paid $2.5 billion to out-of-state energy producers in 2002. Governor Guinn's Nevada Energy Protection Program (NEPP) seeks to finds ways to make Nevada a net exporter of electricity. In particular, much of the state's renewable generation capacity remains untapped. If these resources were exploited, it is likely that Nevada could increase electricity generation and export capacity and reduce reliance on other states for its power needs. Further, exploiting these resources could create jobs within the state often in rural areas that are currently experiencing job losses. Thus, developing our solar, wind, biomass, and geothermal resources may prove to be a powerful economic development tool.

An examination of the stock of renewable resources in Nevada proves that the state has the potential to be a leader in renewable electric generation. Solar resources for concentrating collectors range between 7,000 and 7,500 watts hours per square meter (whm^2), making southern Nevada one of the best sources for this type of generation in the world. Flat-plate collectors can provide a similar amount of generation power. Full utilization of Nevada's wind resources could generate 50,589,000 megawatt hours (mWh) of electricity. The abundance of high-temperature sites in Nevada suggests geothermal could be a lucrative electrical generation resource for the state. A swath of geothermal sites covers portions of the western U.S. In Nevada, over 60 percent of the state has sites with high enough temperatures for electricity generation. The geography of the state does not lend itself as readily to biomass production. The Department of Energy (DOE) rates the stock of biomass resources in Nevada as "fair."

Given the abundance of renewable energy potential in Nevada, it is interesting to evaluate the likely economic impacts of converting to electric generation using the state's renewable resources. Toward that end, we estimate the economic impact, in terms of annual employment and gross state product (GSP), of three different scenarios representing different levels of renewable energy generation in the state. We tie the scenarios to the Nevada Renewable Portfolio Standard (RPS). Thus, Scenario 1 examines current usage, where 3.9 percent of total energy consumed in the state is generated using renewable sources. Scenarios 2 and 3 examine 7 and 15 percent of total state consumption, respectively, attributable to renewable generation. We estimate economic impacts for each scenario using a dynamic economic-impact model designed by Regional Economic Models, Inc. (REMI) that is specially calibrated for Nevada. The estimated employment and GSP impacts reflect the differences from the baseline case (the current level of renewable energy generation as 3.9 percent of total consumption) and the second and third scenarios. As such, the second and third scenario outcomes are relative to the current impacts of renewable energy generation.

According to the model results, current economic impacts of renewable energy are large. An estimated 850 Nevada jobs arise either directly or indirectly from renewable energy generation in the state. If the current proportion of energy consumed is generated by renewable sources, the annual impact on GSP averages $124 million annually in nominal dollars through 2035. Adjusted for inflation, the average annual impact is $67 million chain-weighted 1992 dollars[1]. The largest economic effects are observed at the highest level of renewable energy dependence. When 15 percent of electric needs come from renewable energy generated within the state, over 5,000 jobs can be attributed to the renewable energy industry with an average annual GSP effect of $665 million through 2035. Even lower levels of use have significant impact. More than 2,500 jobs result when 7 percent of generation needs arise from renewable sources. GSP under the "low use" 7 percent generation scenario averages $310 million annually through 2035.

Multiplier effects, which measure the indirect and induced economic activity from direct expenditures on renewable energy generation, are significant. On average, the multiplier effect is the highest for the "low" and "high-use" scenarios, both having annual average multiplier gross state product multipliers of 1.72. The average annual multiplier for the current use scenario is slightly lower at 1.67. Nevertheless, the multipliers show that substantial indirect economic activity is generated by switching to in-state renewable energy generation.

The model results show clear economic benefits in terms of GSP and new employment in the state of Nevada. It is important to note that this economic development supports sustainable growth within the state. Renewable energy generation, on average, is associated with less environmental degradation than generation using nonrenewable energy sources. Air-quality impacts are scant or nonexistent. And, save for electric generation using biomass, renewable sources do not contribute to global warming because fossil fuels are not used. Thus, tallying the economic and environmental benefits of electric-energy generation, it is clear that it could be an important contributor to sustainable economic development.

[1] Chain-weighted 1992 dollars are inflation-adjusted (or real) dollars in 1992 terms. The chain-weighted adjustment accounts for shifts in consumption so that the inflation adjustment matches changes in household consumption expenditures over time.

The Potential Economic Impact of Nevada Renewable Energy Resources

I. Introduction

Rolling blackouts in California and rising energy prices have spurred renewed interest in renewable energy sources, such as wind, geothermal, biomass, and solar power for electricity production, home heating, and home cooling. Alternatives to nonrenewable energy sources such as coal, nuclear fission, and natural gas have many advantages in terms of reducing global carbon dioxide which leads to global warming, air-quality improvements, and other potential environmental and health benefits. Until recently, the market price of nonrenewable energy was low enough that converting to renewable sources did not have clear economic advantages. However, falling costs of electricity generation from renewable sources and rising energy costs for conventional sources are setting the stage for developing some of our renewable resources.

Nevada, with its desert and mountain terrain has substantial capacity for exploiting solar and wind energy resources. Geothermal energy also has potential for home heating and electric-power generation. And, to a lesser extent, biomass, in the form of wood and crop residue, could add to the state's electric-generation capacity.

In 2003, Nevada's electricity consumption is expected to total nearly 36,000 gigawatts hours (gWh). Consumption-growth rates are predicted to average 1.3 to 1.5 percent in northern Nevada and approximately 3 percent in southern Nevada. In part due to population growth in excess of energy infrastructure investment, Nevada paid $2.5 billion to out-of-state energy producers in 2002. Governor Guinn's Nevada Energy Protection Program (NEPP) seeks to finds ways to make Nevada a net exporter of electricity. In particular, much of the state's renewable generation capacity remains untapped. If these resources were exploited, it is likely that Nevada could increase its electricity generation, hence export, capacity and rely less on other states for its power needs. Further, exploiting these resources could create jobs within the state, often in rural areas that are currently experiencing job losses. Thus, developing Nevada's solar, wind, biomass, and geothermal resources may prove to be a powerful economic-development tool.

The purposes of this study are threefold. First, we estimate the stock of renewable energy resources in Nevada, focusing on solar, wind, geothermal, and biomass. Second, we compare prices of electricity generation using conventional methods, such as coal, natural gas, and nuclear fission to electricity generation prices when renewable resources are used. Finally, we outline the potential for renewable resources as an economic-development tool. We will present economic impacts, in terms of employment and gross state product (GSP), attributable to exploiting renewable resources within Nevada for different levels of resource use and price.

This report describes the Department of Energy's (DOE's) estimates of the existing stock of renewable energy in Nevada and the potential for exploitation throughout the state. It also provides an overview of electricity generation prices using renewable and nonrenewable energy sources. In the final section, we present the economic impacts of renewable energy generation in Nevada under three different scenarios. The scenarios reflect the timetable of Nevada's Renewable Portfolio Standard (RPS). As such, we present economic impacts for three scenarios. Scenario 1 analyzes the current level of renewable use, Scenario 2 analyzes a 7 percent increase in renewable energy, and Scenario 3 analyzes a 15 percent increase in renewable energy within the state.

II. Nevada's Renewable Portfolio Standard

The RPS was part of the 1997 Electric Restructuring Legislation passed by the Nevada legislature. The goal of the RPS was to increase use of renewable energy in Nevada. Electric providers within the state were required to acquire renewable electric generation or purchase renewable energy credits representing 1 percent of total consumption. The law was revised on June 8, 2001. The revised law, purported to be the most aggressive RPS in the country, requires a steady shift toward renewable generation through 2013. The law requires renewable energy generation to increase by 5 percent by 2003, 7 percent by 2005, 9 percent by 2007, 11 percent by 2009, 13 percent by 2011, culminating in a 15 percent increase by 2013.

In question is the economic impact of this law. The law does not require that generators use in-state resources. Nevertheless, the law is likely to support in-state renewable generation given the large stock of renewable energy sources in the state. When renewable types are considered, including solar, wind, geothermal, and biomass, Nevada's stock of renewable resources is one of the nation's largest. Thus, in the next section we turn to a discussion of the stock of renewable energy resources within the state by resource type, e.g., solar, wind, geothermal, and biomass. The discussion sheds light on the potential for reliance on renewable energy for electricity generation in Nevada and the potential for export to other states.

III. Renewable Energy Resource Stocks

To understand the potential for renewable fuels for meeting the electric power needs of Nevadans, it is essential to know the stock of the resources. In other words, how large are each of these resources currently and what is their future potential? Additionally, we must know the location of resources. How close are they to urban centers? Are the sources diffuse, spread evenly over the state, or concentrated in certain areas? Given this information, we can more readily assess the potential for renewable sources to meet state's energy demands now and in the future.

Solar Power

Nevada enjoys one of the best environments for solar power generation in the country with the most potential in the southern part of the state. Solar resources for concentrating collectors range between 7,000 and 7,500 watts hours per square meter (whm^2), making southern Nevada one of the best sources for this type of generation in the world (see Figures 1 and 2). Flat-plate collectors can provide a similar amount of generation power. Although not on par with southern Nevada, central and northern Nevada also have significant solar resources. According to the DOE, a photovoltaic array with a collector area equal to the size of a football field could generate 1,217,000 kWh of electricity per year. This is enough to power 122.1 average homes. Alternatively, a concentrating system with a collector area of 200,000 square meters and a facility covering about 150 acres could generate nearly 67,379,000 kWh of electricity per year — enough to power 6,762 homes. The state's resources are sufficient to power many collectors of this sort.

Figure 1. Solar Resource for Concentrating Collectors in the U.S. and Nevada: Source DOE/(Office of Electric Energy and Renewable Energy) EERE

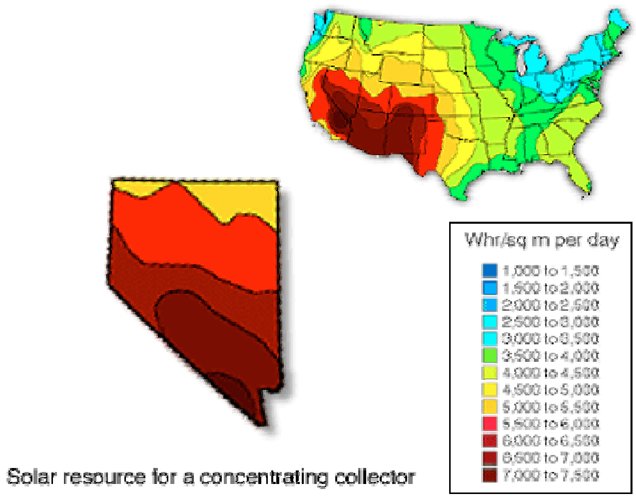
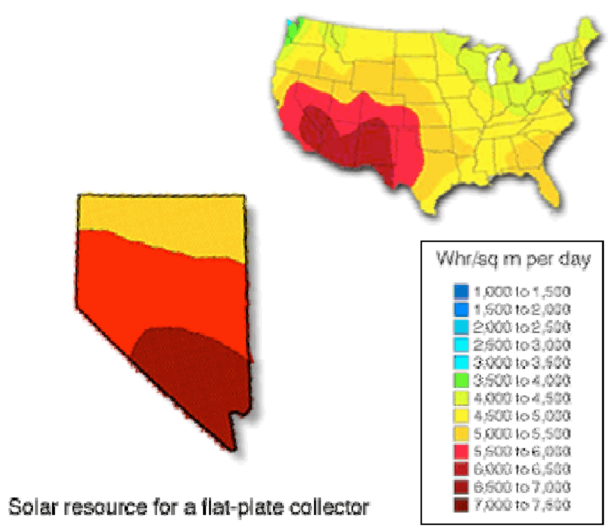


Figure 2. Solar Resource for Flat-Plate Collectors in the U.S. and Nevada: Source DOE/(Office of Electric Energy and Renewable Energy) EERE



Biomass

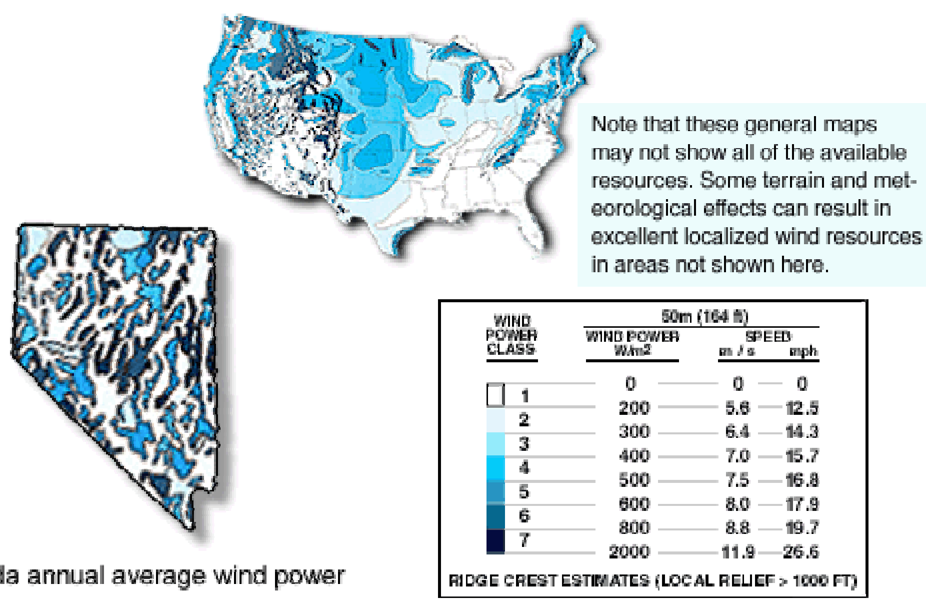
Biomass resources, including wood, timber residue, energy crops, and agricultural residues, such as wheat straw, corn stover (leaves, stalks, and cobs), and orchard clippings is one of the most widely exploited energy resources in the world. However, the terrain and vegetation in Nevada do not lend themselves to large stocks of biomass resources. Thus, the DOE rates the stock of biomass resources in Nevada as “fair.” The predominant biomass resource in the state is urban wood residue. The DOE estimates that this resource, if fully exploited, could exceed 307,000 tons per year. Utilization of this resource could account for 0.5 billion kWh of electricity annually. This could provide electricity to 49,000 average homes annually within the state.

Wind

The geography of Nevada is ideal for wind generation of electricity. California, in contiguous and geomorphically similar areas, has already begun to successfully exploit this resource. Wind farms dot the California landscape near Palm Springs, San Francisco, and a host of other sites.

The DOE recognizes seven classes of wind resources that are based on typical wind speeds. The classes range from class 1 (the lowest) to class 7 (the highest). Class 4 and above are considered good resources. Totaling land area with class 4 or higher resources and subtracting unsuitable urban, range, and forest land leave 1.3 percent of Nevada’s total land area available for productive wind generation. Of those acres, 10 percent would actually be covered. Full utilization of Nevada wind resources under these conditions could generate 50,589,000 mWh of electricity (see Figure 3).

Figure 3. Annual Average Wind Power by Class for the U.S and Nevada. Source DOE/(Office of Electric Energy and Renewable Energy) EERE



Geothermal

Geothermal energy derives from the natural heat of the Earth's interior where temperatures reach 7000°F. The heated water and steam rise to the earth’s surface as water flows through permeable rock. It can be used directly for heating homes or for geothermal heat pumps which can provide winter heat or summer cooling.

Geothermal energy can by tapped using two resources: hydrothermal fluid resources (reservoirs of steam or very hot water) and earth energy (the heat contained in soil and rocks near the earth's surface). Hydrothermal fluid resources are suitable for electricity generation. Earth energy can be exploited for direct use to heat homes or businesses and/or geothermal heat pumps.

According to the DOE's assessment, Nevada has geothermal resources that can be used for electricity generation. However, the precise stock of the resource is difficult to assess. Each site has distinct geologic characteristics in terms of pressure, temperature, and location. Thus, geothermal generation plant design and generation potential vary significantly from site to site.

Nevertheless, the abundance of high-temperature sites in Nevada suggests geothermal could be a lucrative electricity generation resource for the state (see Figure 4). A swath of geothermal sites covers portions of the western U.S. In Nevada, over 60 percent of the state has sites with high enough temperatures for electricity generation. Geothermal heat pumps and direct use are possible in the remainder of the state.

Figure 4. Geothermal Resources in the U.S. and Nevada. Source: DOE/EERE

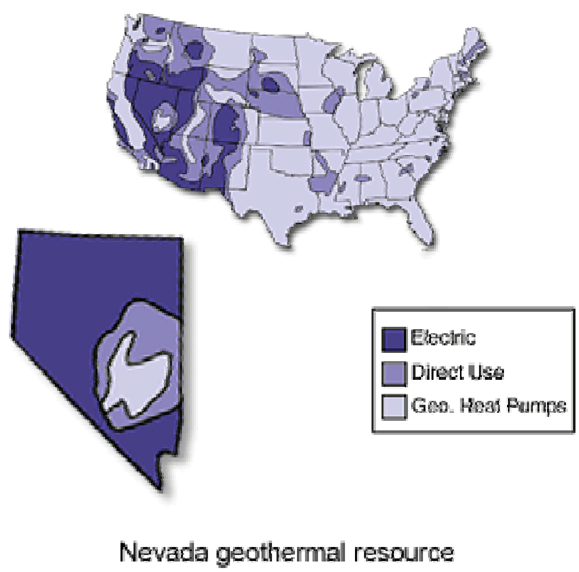
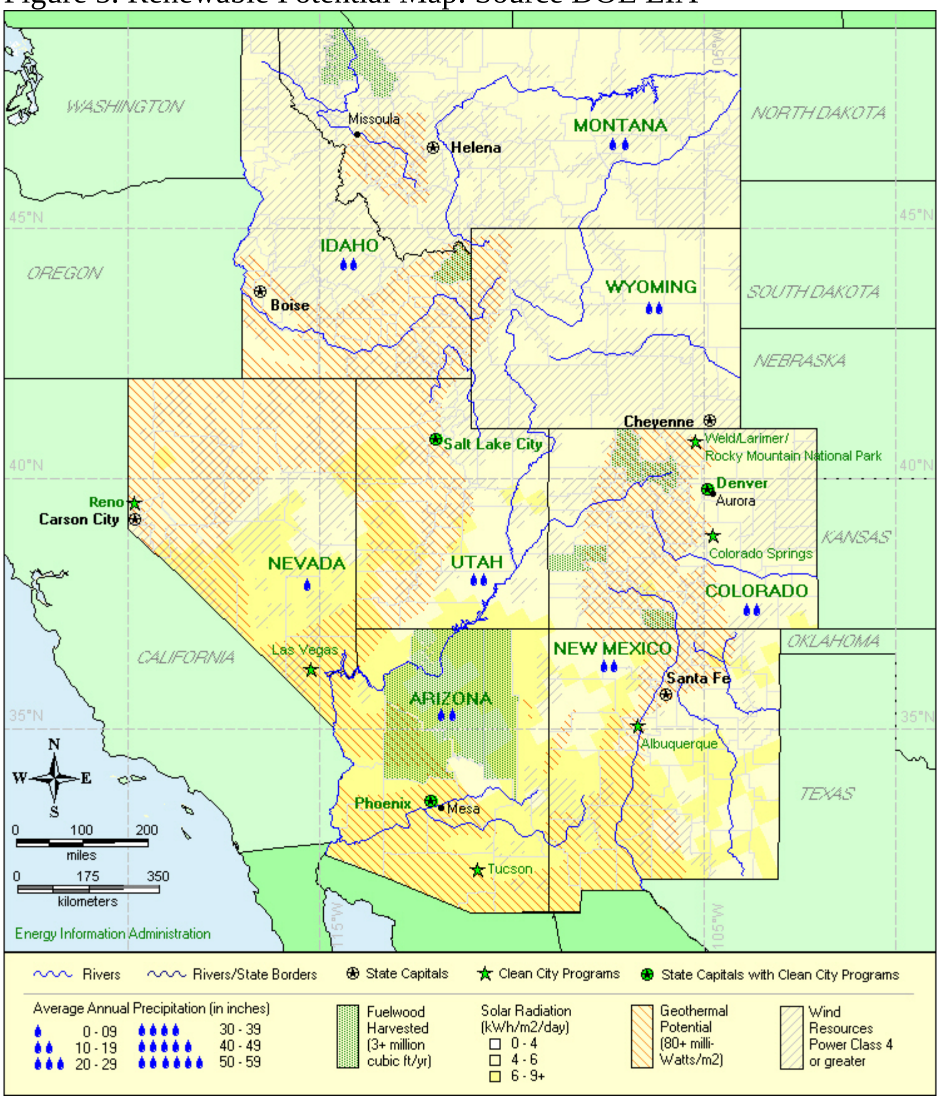


Figure 5 compares the potential for development of different sources of renewable energy in Nevada to that of other western states. Nevada's mix of high geothermal potential, wind resources of class 4 or greater, and large area of solar radiation with potential for generating 6 – 9 $kWh/m^2/day$ rivals and often surpasses that of every other Rocky Mountain state. The geography of the resources also is telling. A large stock of solar and wind resources is located near current population centers. For example, the potential for solar generation is greatest near fast-growing urban Clark County. Similarly, Washoe County, another relatively densely populated county, enjoys a large share of geothermal and wind energy generation potential.

In summary, the available data suggests that Nevada has a vast stock of renewable energy resources. The question remains: When will these resources be tapped for electricity generation in the state and export to other states? Economic theory tells us that the timing that a resource is put into use is dependent upon the price of electricity, the relative cost of developing the resource, and any subsidies or taxes that may encourage or discourage the use of that resource. Therefore, in the next section we turn to a discussion of the costs of generating electricity from different renewable and nonrenewable sources. We find that renewable energy is fast becoming an economically viable electricity generation option.

Figure 5. Renewable Potential Map: Source DOE EIA



IV. Electrical Generation Prices for Renewable and Nonrenewable Fuels

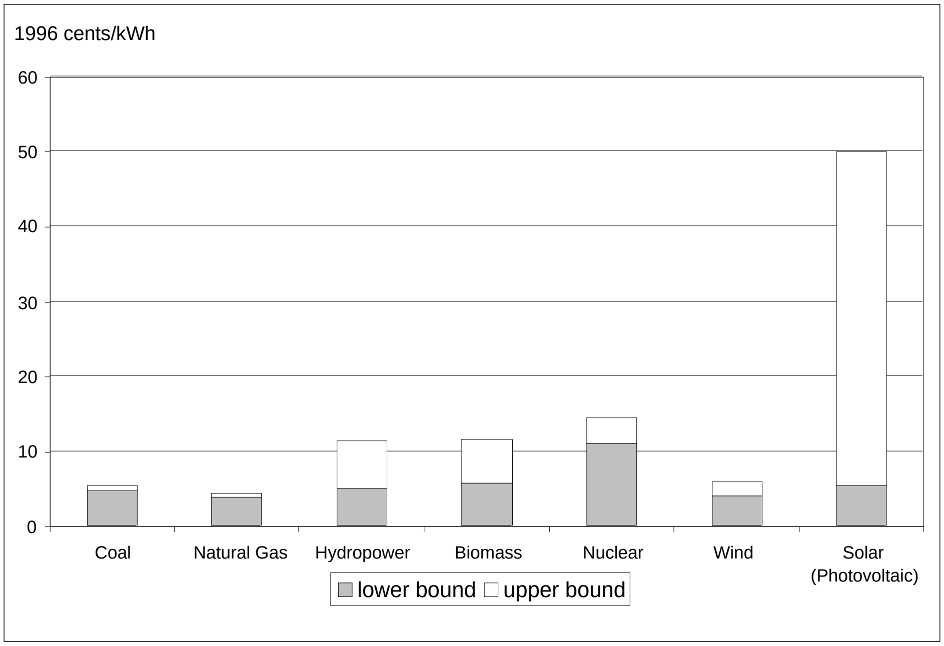
The second component of the study examines the economic viability of existing resources. Of course, all units of renewable power, even with each category, cannot be generated for the same price. Some wind farms may be more productive than others simply due to weather patterns. Thus, prices in our study represent the best available information about the generation prices for the “average” renewable resource within each category.

The California Energy Commission’s 1996 *Energy Technology Status Report* details levelized costs for electrical power generation for conventional and renewable sources. The levelized cost of a generation facility is the present value of the average cost of electricity generation over the life of the generation facility per kWh. As such, it allows us to compare costs, including capital, construction, and labor for different types of generation facilities. Because levelized costs can vary substantially from facility to facility, the report offers estimates of lower- and upper cost-bounds by fuel type.

Figure 6 graphs the lower bound and upper bound for levelized costs, in 1996 cents, of coal, natural gas, hydropower, biomass, nuclear, wind, and solar electric generation facilities. Geothermal costs are omitted due to their highly site-specific nature. In 1996, coal and natural gas generation plants provided the cheapest and least variable sources of electricity generation. Wind power is nearly as economical as coal and gas, but displays somewhat more variability. Solar power spans the range from very economical at 5.5 cents/kWh using a proposed non-concentrating thin-film technology to as much as 50 cents/kWh for older, less efficient, technologies. Biomass and hydropower offer comparable and economic generation costs, whereas nuclear-power generation costs are large and highly variable.

The reader should keep in mind that levelized costs are market based and do not therefore include any insight into environmental costs. Relative-cost rankings may change substantially if the environmental cost of carbon-based fuels, such as natural gas and coal or the health, safety, and waste storage costs of nuclear power, are considered. Environmental costs are beyond the scope of this study and we mention these simply as a caveat to strict cost comparisons. Nevertheless, generating electricity from renewable sources is associated with fewer environmental externalities, on average, than generating using nonrenewable sources. Thus, in terms of social costs (the sum of economic and environmental costs), renewable sources are almost certainly less expensive.

Figure 6. Levelized Costs of Major Energy Sources and Renewable Energy Sources
Source: California Energy Commission



V. A Brief Discussion of the Current State of Electricity Generation Using Renewable Sources in Nevada

According to the DOE's division of Energy Efficiency and Renewable Energy, 18,932 gWh, or 53 percent of the electricity generated in Nevada comes from coal-fired power plants (see Table 1). Natural gas is the second-most popular source of electric generation with 12,822 gWh generated accounting for 36 percent of the total state's generation. Petroleum and hydropower account for an additional 6.8 and 0.2 percent, respectively. Renewable sources make up the balance, with an estimated 1,384 gWh, or 3.9 percent of Nevada's electricity generation coming from renewable resources such as wind, geothermal, solar, and biomass.

Table 1. Sources of Electric Power Generation in the U.S and Nevada: 2003
Source: U.S. Department of Energy, Energy Efficiency and Renewable Energy 1999.
Total Energy Use Increased from the 1999 levels by the Growth in Population.

	Millions of KWH (gigawatts)			
	US		Nevada	
	Level	Percent	Level	Percent
Nuclear	753,900	19.8%	0	0.0%
Coal	1,967,700	51.8%	18,932	53.1%
Hydropower	108,800	2.9%	65	0.2%
Natural Gas	612,400	16.1%	12,822	36.0%
Petroleum	273,100	7.2%	2,437	6.8%
Renewables	84,100	2.2%	1,384	3.9%
Total	3,800,000	100.0%	35,640	100.0%

VI. Economic Impacts of Renewable Energy in Nevada

Given the Nevada RPS, it is helpful, from a policy perspective, to quantify the economic impact of increased dependence on renewable energy in Nevada. For simplicity, we focus on employment and GSP impacts at different levels of dependence on renewable energy generation. Employment impacts may arise from a variety of sources. There will be direct employment impacts from constructing and maintaining renewable generation facilities. Second round, or indirect employment impacts, can follow as Nevada firms that supply labor and or materials to generation facilities expand. Finally, new jobs can be created in the retail, services, and other sectors that support consumption activities. Similarly, direct GSP impacts will arise from the construction, maintenance, and operation of renewable generation facilities. Indirect and induced effects from increased demand for renewable energy generation products and increased household wealth, respectively, are also an important source of economic activity.

In the following section, we quantify the sum of direct and indirect economic impacts, in terms of employment and GSP, of developing Nevada's renewable resources. We focus on three scenarios: current-use, low-use, and a representative high-use scenario. The three scenarios deepen our insight of the economic impact we may expect from the implementation of the Nevada RPS. To estimate the economic impacts, we employ a structural demographic and economic model developed by Regional Economic Models, Inc. (REMI) specifically for Nevada. In the following section, we first discuss the REMI model and its assumptions. Next we outline each of the three scenarios and the resulting employment and GSP impacts. We conclude the section with a comparison of the different model results.

The REMI Model

The REMI model is a state-of-the-art econometric forecast model that accounts for dynamic feedbacks between economic and demographic variables. The REMI model is nationally recognized by the business and academic community as the best regional forecast tool available. The REMI model forecasts county employment based on a model that includes over 100 stochastic and dynamic relationships and a number of identities. The national economy is taken as exogenous. The relationships span 53 sectors of employment figures, detailed population and demographic forecasts that include economic and non-economic migration, capital formation, and county-level import export relationships. A complete explanation of all of the relationships contained in the model is given in Regional Economic Modeling: A Systematic Approach to Economic Forecasting and Policy Analysis by George I. Treyz.

The REMI model allows for an open economy, thus the model *explicitly* accounts for trade amongst the counties in Nevada and throughout the U.S. If, for instance, a downturn in California causes employment and personal income to fall, this is reflected by a drop in tourism to northern Nevada and Washoe County. The same is true for all other industries in Washoe County; if demand for exported products from local industries falls anywhere in the U.S., it is automatically included in the forecast. This type of detailed trade modeling, though rare, is particularly important for a small economy such as Nevada that is very dependent on exports for its economic base.

The REMI model works particularly well for economic impact assessment because it is a dynamic model. The word "dynamic" in economics means that past events are allowed to influence current and future events. So, for example, an increase in demand for electricity will cause electricity prices to rise in the model in the next period. The price rise will translate into lower demand in the future, all else equal.

Another important component of the REMI model is the detailed provision for capital investment. Investment in the economic sense is buildings and equipment that are used for producing goods and services. Therefore, the model incorporates data on past investment, including the cost of new casino and hotel construction, in the estimation process. Demand for labor and capital investment is included through a block of equations in the model. Another important block of equations is the population and labor-supply block. This block relates migration and changes in population to the supply of workers for the different industries in the county. A unique feature of this block of equations is the decomposition of migrants into those drawn by economic variables and those from non-economic, including retired persons. Again, this feature is helpful when modeling the economy of a state with a disproportionately high percentage of retired persons. Finally, the REMI model has a block of equations that accounts for wages, prices, and profits of firms.

In the REMI model, the labor and capital demand block, the population and labor-supply block, and the wage, prices, and profits block are allowed to interact, thereby mimicing the economic relationships. The dynamic relationships allow for eventual return to equilibrium. For example, if wages are high relative to those in Utah, the model will draw migrants from Utah to work in Nevada. Over time, as new migrants come and increase the supply of labor, wages are forced down and are eventually equilibrated with those of Utah. This allows for economic-impact estimates that are reflective of theoretically sound economic relationships.

The model employed divides Nevada into five regions--Clark County, Nye County, Lincoln County, Washoe County and Carson City, and the remaining counties are combined to form a fifth region. The data used to construct the model begin in 1969. Because Bureau of Labor Statistics' (BLS) personal income data are reported with a two-year lag, the most recent historical data in the model are from 1998.   In an effort to ensure that the most current data are used in the forecast, we update the model with employment figures from the Nevada Department of Employment, Training, and Rehabilitation.

Once calibrated, the REMI model provides forecasts for economic and demographic variables, such as population, inflation-adjusted GSP, and industry-specific final demand, on which we may base our tax forecasts. It is very important to note that the final-demand forecasts used to ultimately forecast taxable sales, sales tax, and room tax encompass *all* of the information contained in the REMI model. Thus, the economic impacts arising from the model are based on complicated, but statistically accurate models of the Nevada and U.S. economies.

The Scenarios

We analyze three scenarios.

- First, we look at the current economic impact of renewable energy on the State of Nevada. We provide an assessment of total jobs and GSP that is either directly or indirectly attributable to renewable energy, assuming that the current proportion of consumption generated by renewable sources stays at the current value of 3.9 percent through 2035.
- In Scenario 2, we analyze "low use" of renewable resources that includes generating 7 percent of Nevada's electrical consumption from a mix of wind, solar, geothermal, and biomass from 2003 through 2035. This is the level of commitment required to renewable energy sources by 2005 under Nevada's RPS.
- In Scenario 3, renewable energy will generate 15 percent of current consumption from 2003 through 2035. This corresponds to the final Nevada RPS requirements that 15 percent of electricity generation come from renewable sources by 2013.

Economic Impacts

<u>Model Assumptions</u>

For the economic-impact model, it is necessary to assess the total cost, in dollars, of the electricity generated using renewable sources. Of course, there is wide variation in the costs of electricity generation from energy source to energy source. There is also variation in generation costs even though the power comes from the same energy source. The productivity of solar power plants varies with plant location, weather, and a host of other factors affecting generation costs. Similarly, wind power costs are a function of average local wind speeds, construction costs, and other weather-related phenomenon. For modeling purposes, it is necessary to choose a "representative plant" cost for each generation type. For this study, we assume that the levelized cost of electricity for the average plant is equal to the national average for that energy source. Table 2 gives average levelized costs for the renewable energy generation sources of interest used in the model. The data are taken from the California Energy Commission's 1996 *Energy Technology Status Report.*

For simplicity, we assume that the relative prices of electric generation by renewable and nonrenewable sources remains constant over the forecast time frame. Of course, given increased investment in solar and wind resource technologies, costs of these generation sources are likely to fall somewhat relative to other technologies. Unfortunately, reliable future renewable cost forecasts are not available. Nevertheless, the assumption of constant relative prices is almost certainly a harmless simplifying assumption. Table 3 gives the estimated expenditures within Nevada under the different scenarios.

Table 2. Estimates of Levelized Costs for Electric Generation by Energy Source Type, Cents/kWh in Real 1996 Dollars.

Estimates of Levelized Costs for Electric Generation by Type (cents/kWh 1996 dollars)

	lower bound	upper bound	cost for model
Coal	4.8	5.5	5.15
Natural Gas	3.9	4.4	4.15
Hydropower	5.1	11.3	8.2
Biomass	5.8	11.6	8.7
Nuclear	11.1	14.5	12.8
Wind	4.0	6.0	5
Solar (Photovoltaic)	5.5	50.0	27.75
Wind (with PTC)	3.3	5.3	4.3

PTC=federal production tax credit

*costs do not include subsidies or environmental costs

Source: California Energy Commission's 1996 Energy Technology Status Report

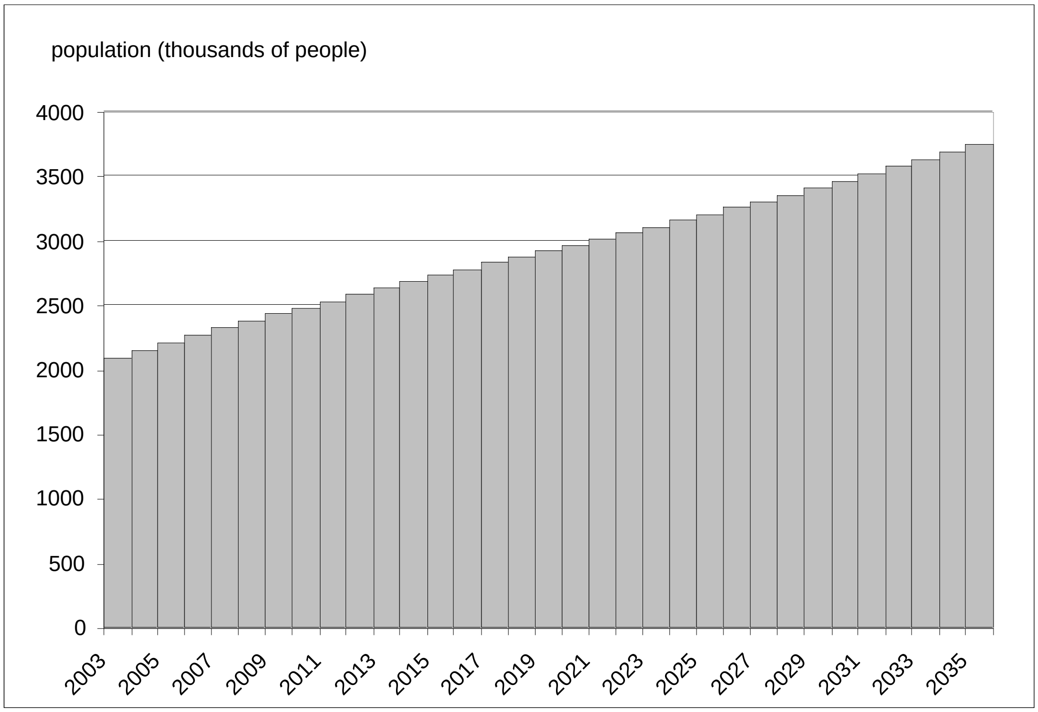
<u>Scenario 1: Current Use with 3.9 Percent of Consumption Generated by Renewable Sources.</u>

Scenario 1 describes the economic impact, in terms of employment and GSP, from producing the current level of electricity generation using renewable energy sources within the state. We assume that 35,640 gigawatts of electricity will be consumed in Nevada in 2003. We arrive at this number by taking the DOE Energy Information Administration (EIA) estimate of energy usage in Nevada in 1999 and allowing number to grow at an annual rate that matches population growth within the state. We apportion the electricity to generation sectors by the DOE EIA's estimate of energy generation, by source, within the state. According to the resulting estimates, 3.9 percent, or 1,384 gWh, is currently generated using renewable sources. For the forecast of employment and GSP impact, we assume that the value energy production in Nevada grows at a rate equal to the expected population growth rate plus the expected rate of inflation in the personal consumption index (PCE) (see Figure 7 for population growth and Table 3 for the dollar value of renewable energy consumed each year). By assumption, the proportion of electricity generated by renewable sources remains constant at 3.9 percent.

The economic-impact model results are reported in Figures 8 and 9 and Tables 4 and 5. As of 2003, we estimate that renewable energy generation is responsible for over 850 jobs in Nevada directly, indirectly, or through induced consumption effects.
Over the range of the forecasted impact, production efficiency increases somewhat causing the total employment impact to fall slightly. When changing efficiency is considered, the employment impact stabilizes at around 730 jobs annually.

The model results show that GSP is significantly affected by renewable energy generation if 3.9 percent of total state consumption is generated using renewable sources within the state (see Figure 9 and Table 5). The annual GSP impact averages $124 million annually in nominal dollars through 2035. Adjusted for inflation, the average annual impact is $67 million chain-weighted 1992 dollars.[2] The gross state product, in terms of chain-weighted 1992 dollars is nearly $70 million in 2003. Production efficiency dampens the impact somewhat through 2012, where real GSP effects fall to $66 million. Rising population growth and corresponding increased energy demand boost GSP effects in the long term. By 2035, the GSP attributable to renewable sources will rise to $71 million chain-weighted 1992 dollars.

Figure 7. Nevada Population and Population Growth Forecast: 2003 – 2035. Source: Center for Business and Economic Research, UNLV



[2] Chain-weighted 1992 dollars are inflation-adjusted (or real) dollars in 1992 terms. The chain-weighted adjustment accounts for shifts in consumption so that the inflation adjustment matches changes in household consumption expenditures over time.

Table 3. Renewable Energy Expenditure Assumptions, Millions of Dollars, for Economic Impact Models for Current Use (3.9 Percent of Current Consumption), Low Use (7 Percent of Current Consumption), and High Use (15 percent of Current Consumption). *

	Current Use 3.9 % of Total Consumption		Low Use 7 % of Total Consumption		High Use 15 % of Total Consumption	
	Nominal (Millions of $)	2003 Dollars (Millions of $)	Nominal (Millions of $)	2003 Dollars (Millions of $)	Nominal (Millions of $)	2003 Dollars (Millions of $)
2003	94.600	94.600	222.910	222.910	477.665	477.665
2004	99.505	97.368	234.468	229.432	502.432	491.64084
2005	104.436	100.020	246.088	235.683	527.332	505.03508
2006	109.431	102.579	257.859	241.712	552.554	517.95519
2007	114.500	105.052	269.802	247.540	578.147	530.44379
2008	119.631	107.423	281.892	253.126	604.055	542.4118
2009	124.879	109.735	294.259	258.574	630.556	554.08802
2010	130.277	111.998	306.979	263.908	657.812	565.51627
2011	135.869	114.260	320.154	269.238	686.045	576.93775
2012	141.599	116.506	333.656	274.530	714.977	588.2787
2013	147.458	118.722	347.462	279.751	744.561	599.46561
2014	153.450	120.909	361.582	284.904	774.819	610.50774
2015	159.567	123.064	375.995	289.981	805.704	621.38885
2016	165.814	125.187	390.717	294.985	837.250	632.11051
2017	172.212	127.284	405.791	299.925	869.552	642.69646
2018	178.746	129.351	421.188	304.796	902.547	653.13533
2019	185.443	131.393	436.969	309.607	936.363	663.44353
2020	192.324	133.418	453.182	314.379	971.104	673.67008
2021	199.456	135.453	469.988	319.174	1,007.116	683.94353
2022	206.884	137.514	487.490	324.031	1,044.622	694.35235
2023	214.598	139.604	505.669	328.955	1,083.576	704.9033
2024	222.612	141.720	524.553	333.942	1,124.041	715.59079
2025	230.927	143.865	544.145	338.996	1,166.024	726.42103
2026	239.591	146.046	564.560	344.135	1,209.771	737.4326
2027	248.667	148.279	585.948	349.397	1,255.602	748.70863
2028	258.130	150.563	608.246	354.778	1,303.384	760.23918
2029	267.977	152.887	631.447	360.255	1,353.101	771.97454
2030	278.197	155.246	655.528	365.813	1,404.704	783.88535
2031	288.815	157.633	680.548	371.438	1,458.317	795.93867
2032	299.909	160.069	706.690	377.178	1,514.336	808.23827
2033	311.464	162.554	733.919	383.033	1,572.683	820.78512
2034	323.455	165.075	762.172	388.976	1,633.227	833.51894
2035	335.848	167.622	791.376	394.975	1,695.805	846.3756

* Expenditures remain constant as a proportion of electricity consumed. Total expenditures grow with the general price level and population.

Figure 8. Employment Impact Scenario 1 with 3.9 Percent of Consumption Generated by Renewable Sources: Thousands of Jobs In Nevada Created in Nevada.

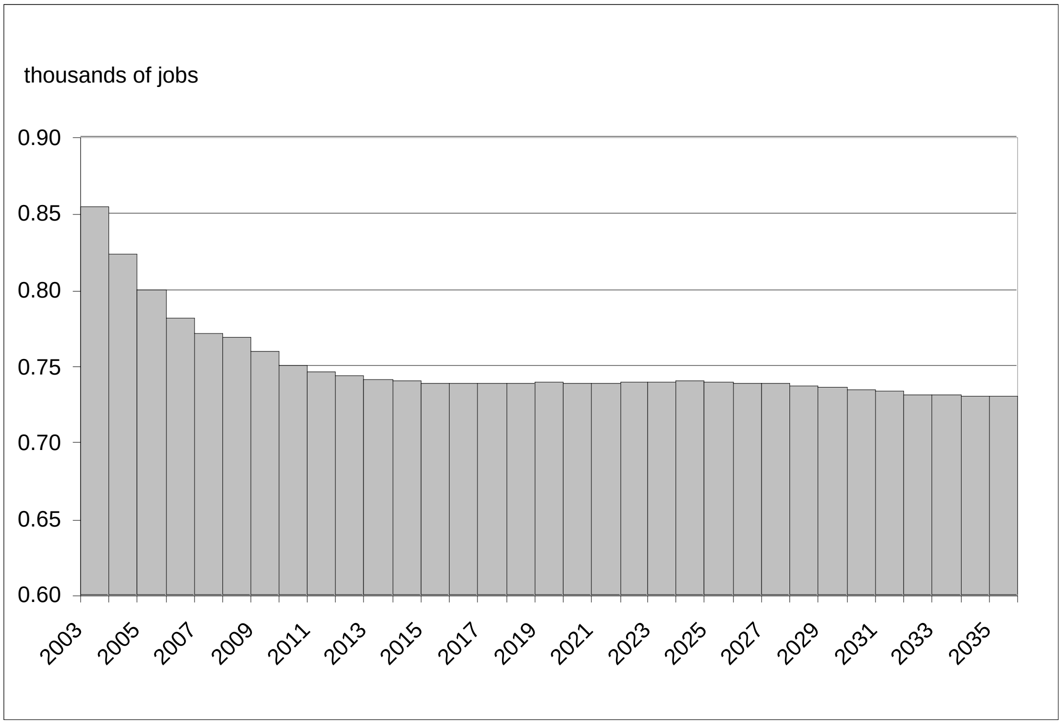
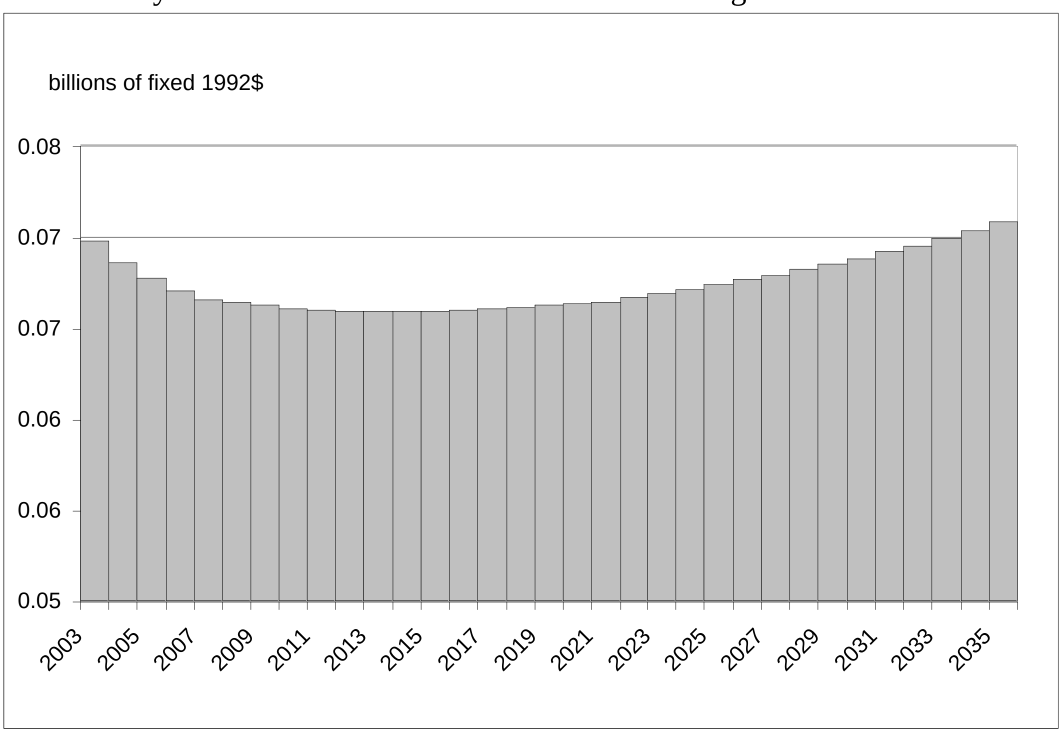


Figure 9. Gross State Product Impact Scenario 1 with 3.9 Percent of Consumption Generated by Renewable Sources: Billions of Chain-weighted 1992 Dollars.



Scenario 2: Low Use with 7 Percent of Consumption Generated by Renewable Sources.

Now we turn to an examination of the economic impact of increasing Nevada's dependence on renewable energy sources. The estimated employment and GSP impacts reflect the differences from the baseline case (the current level of renewable energy generation as 3.9 percent of total consumption) and the second and third scenarios. As such, the second and third scenario outcomes are relative to the current impacts of renewable energy generation.

Scenario 2 examines the economic impact, in terms pf GSP and employment, if 7 percent of Nevada's electricity demand is generated by renewable sources within the state. Nevada's RPS requires that we meet this threshold by 2005.

The proportion of total electricity demanded that is generated using renewable sources remains constant over the 2003 – 2035 time horizon, by assumption. As in Scenario 1, we allow expenditures to grow by the rate of forecasted population growth with an upward adjustment for expected inflation.

Figure 10 and Table 3 give the employment impact, in terms of thousands of jobs within the state of Nevada, of the expenditures arising from Scenario 2. According to the model results, if 7 percent of Nevada's total electric needs in 2003 were generated by renewable sources within the state, direct, indirect, and induced employment would total 2,549 jobs. As in Scenario 1, increasing production efficiency causes employment impacts to taper off over time. Employment impacts stabilize at 1,900 jobs in the long term.

Gross state product under the "low use" 7 percent generation scenario averages $310 million annually through 2035 in current dollars and $170 million in chain-weighted 1992 dollars. Analogous to Scenario 1, GSP impacts are large initially then fall as energy -production efficiency rises in the first decade of converting to increased dependence on renewable sources. In 2003, 7 percent of consumption generated by renewable sources translates into a GSP impact of $191 million chain-weighted 1992 dollars (see Table 5. However, by 2017, growing demand for electricity will begin to outpace energy -efficiency generation savings. At the trough, the GSP impact of Scenario 2 is $163 million in chain-weighted 1992 dollars. The real economic value rises to $175 million by 2035.

Figure 10. Employment Impact Scenario 2 with 7 Percent of Consumption Generated by Renewable Sources: Thousands of Jobs In Nevada Created in Nevada.

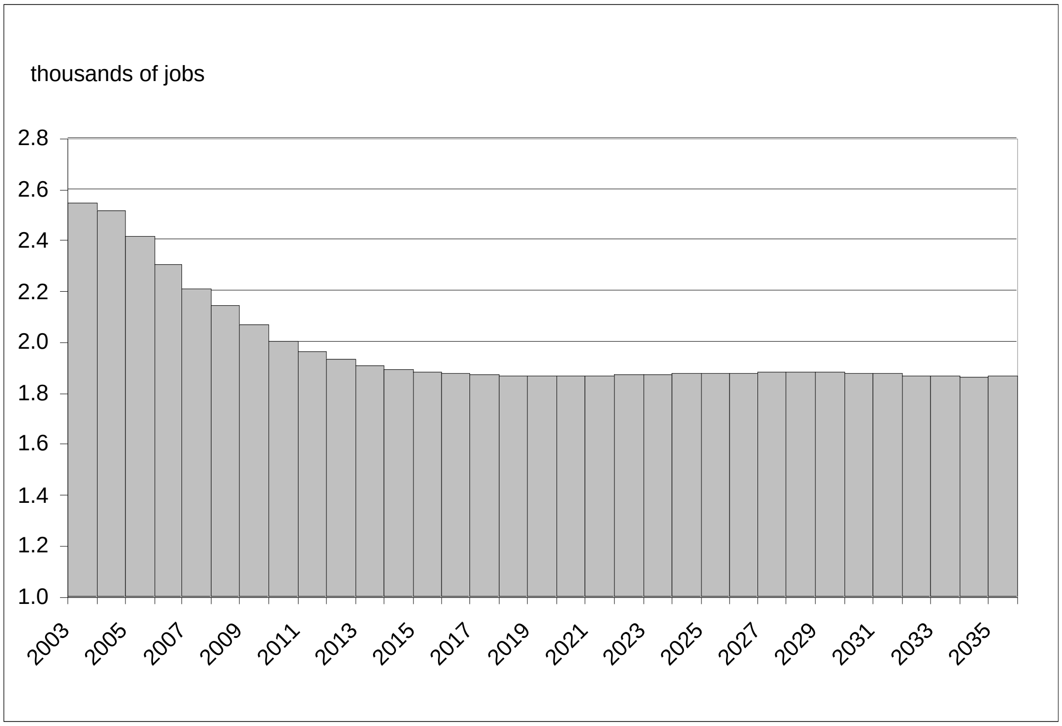
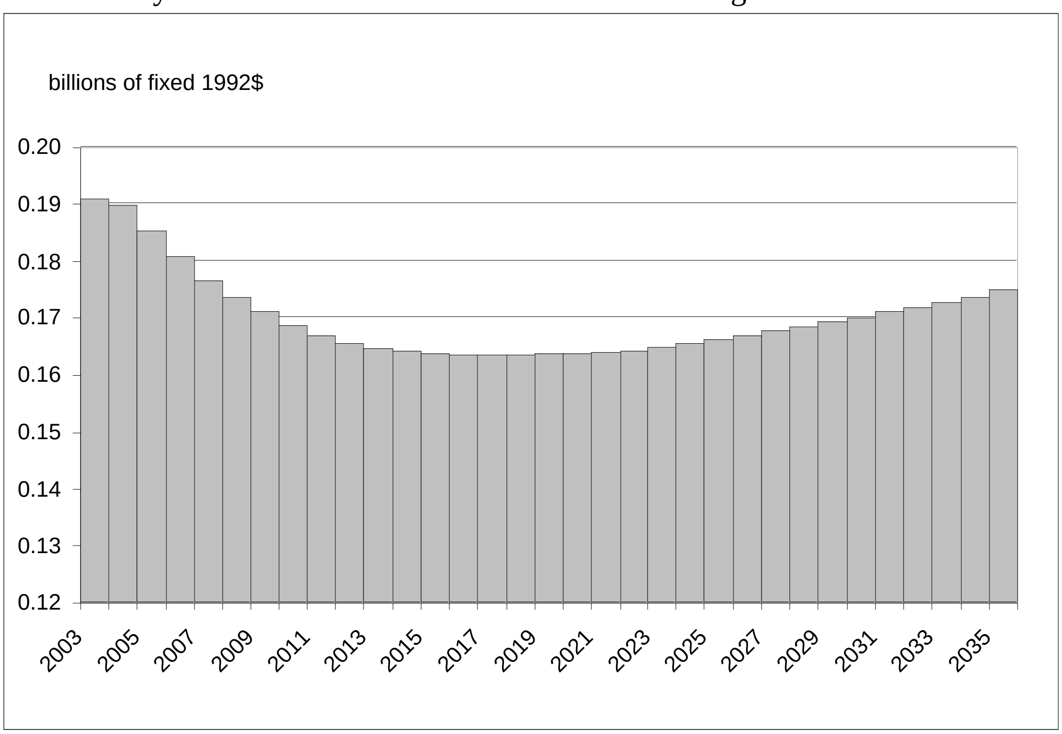


Figure 11. Gross State Product Impact Scenario 2 with 7 Percent of Consumption Generated by Renewable Sources: Billions of Chain-weighted 1992 Dollars.

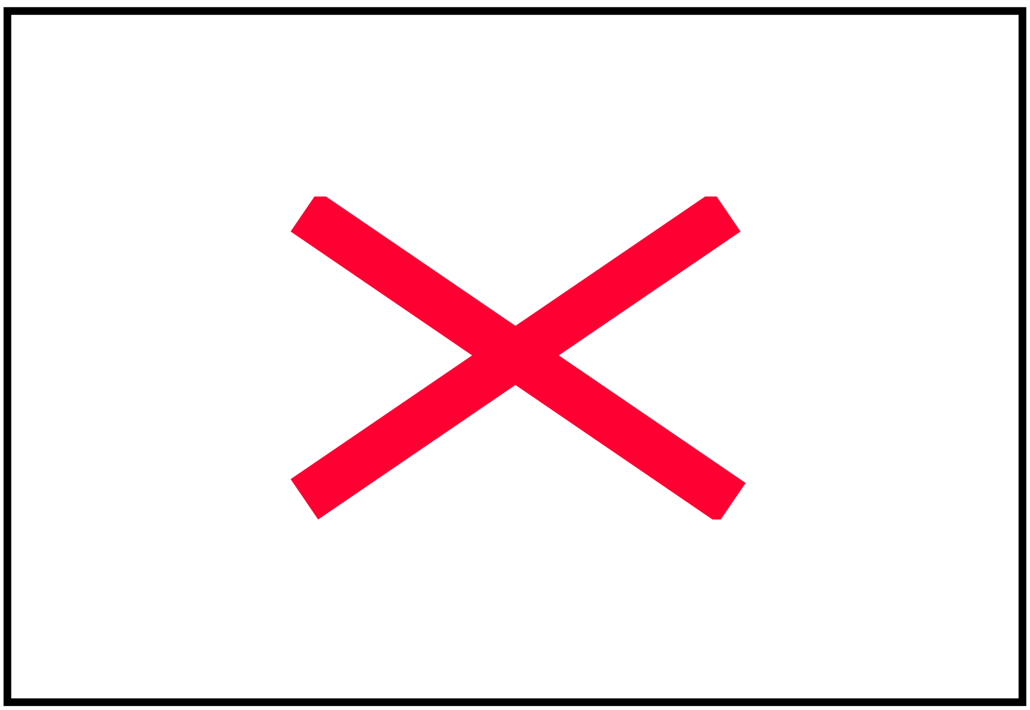


Scenario Three: High Use with 15 Percent of Consumption Generated by Renewables

Scenario 3 models the highest proportional use category. We assume that 15 percent of total electricity demanded in Nevada is produced within the state using renewable energy sources. The price and demand assumptions are the same as for Scenarios 1 and 2.

Employment impacts are given in Figure 12 and Table 4. Employment impacts are substantial when 15 percent of Nevada's total electricity demanded is generated by renewable energy sources within the state. Initially, almost 5,500 jobs will be either directly or indirectly attributable to renewable energy generation. Increased efficiency of energy generation means that the employment impacts fall to approximately 4,000 jobs.

Figure 12. Employment Impact Scenario 3 with 15 Percent of Consumption Generated by Renewable Sources: Thousands of Jobs in Nevada Created in Nevada.



The total value of goods and services attributable to renewable energy generation is given by the GSP in Figure 13 and Table 5. The GSP effect, in current dollars, averages $665 million annually through 2035. The numbers are smaller, but still substantial, when inflation is considered. Initially, the GSP impact is equal to $409 million chain-weighted 1992 dollars. Efficiency improvements cause the total dollar value of GSP effects to fall to $350.2 million, in real 1992 chain-weighted dollars, by 2016. Following that, demand pressure begins to override increased efficiency and the GSP economic impact turns the corner. By 2035, direct and indirect GSP impacts total $375 million in chain weighted 1992 dollars.

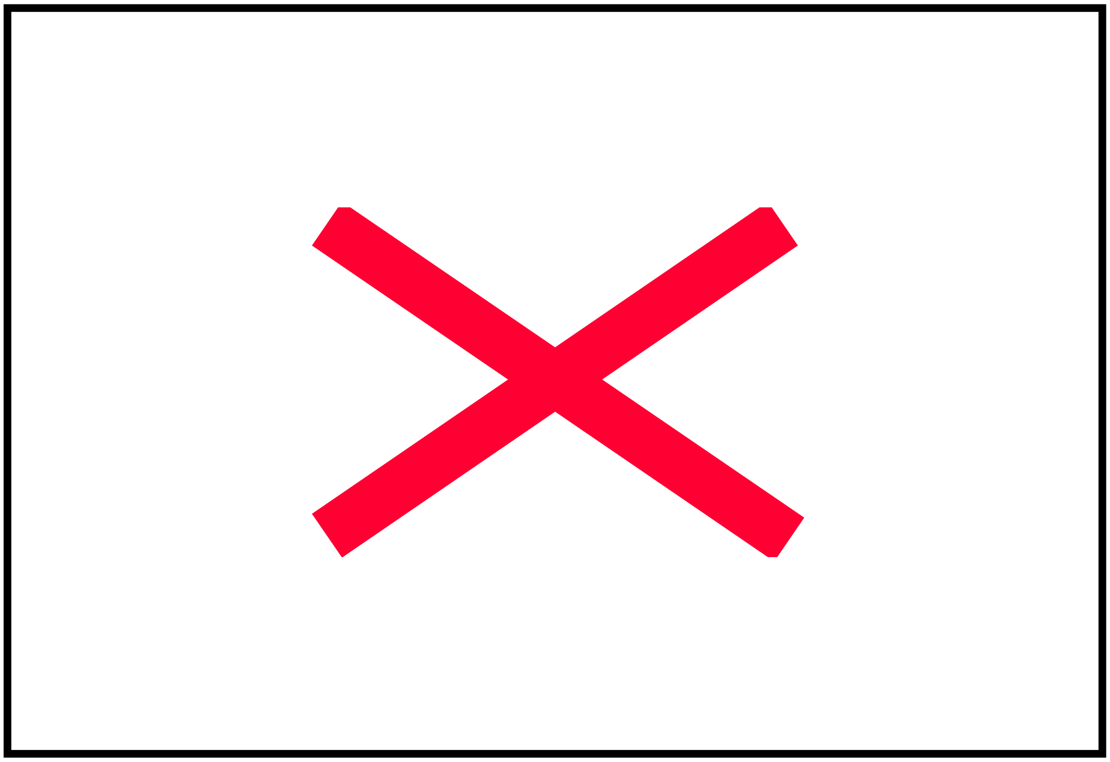
Table 4. Employment Impacts of Renewable Energy Generation for Scenarios 1,2,and 3: Thousands of Jobs in Nevada.

Year	Scenario One Current Use 3.9 Percent of Total Consumption (Thousands of Jobs)	Scenario Two Current Use 7 Percent of Total Consumption (Thousands of Jobs)	Scenario Three Current Use 15 Percent of Total Consumption (Thousands of Jobs)
2003	0.8549	2.549	5.464
2004	0.8245	2.517	5.394
2005	0.8006	2.412	5.167
2006	0.7823	2.305	4.937
2007	0.772	2.214	4.739
2008	0.7693	2.145	4.591
2009	0.76	2.071	4.432
2010	0.7509	2.007	4.294
2011	0.7467	1.964	4.201
2012	0.7435	1.931	4.13
2013	0.7418	1.91	4.085
2014	0.7405	1.894	4.051
2015	0.7395	1.883	4.027
2016	0.739	1.876	4.013
2017	0.739	1.871	4.003
2018	0.7395	1.87	3.999
2019	0.7399	1.869	3.998
2020	0.7394	1.868	3.995
2021	0.7391	1.868	3.995
2022	0.7401	1.871	4.002
2023	0.7401	1.873	4.006
2024	0.7407	1.875	4.012
2025	0.7402	1.878	4.017
2026	0.7395	1.879	4.021
2027	0.7391	1.88	4.022
2028	0.738	1.88	4.024
2029	0.7371	1.88	4.023
2030	0.7345	1.876	4.016
2031	0.734	1.875	4.013
2032	0.7319	1.87	4.002
2033	0.7316	1.868	3.999
2034	0.7305	1.865	3.991
2035	0.7311	1.866	3.995

Table 5. Gross State Product Impacts of Renewable Energy Generation for Scenarios 1,2,and 3: Nominal Dollars and Billions of Chain-weighted 1992 Dollars

	Current Use 3.9 % of Total Consumption		Low Use 7 % of Total Consumption		High Use 15 % of Total Consumption	
Year	Nominal (Billions of Chained 1992 $)	Billions of Current Dollars	Nominal (Billions of Chained 1992 $)	Billions of Current Dollars	Nominal (Billions of Chained 1992 $)	Billions of Current Dollars
2003	0.070	0.089	0.191	0.242	0.409	0.519
2004	0.069	0.089	0.190	0.246	0.407	0.527
2005	0.068	0.090	0.185	0.245	0.397	0.526
2006	0.067	0.091	0.181	0.244	0.387	0.524
2007	0.067	0.092	0.177	0.244	0.379	0.524
2008	0.066	0.094	0.174	0.245	0.372	0.526
2009	0.066	0.096	0.171	0.247	0.367	0.529
2010	0.066	0.097	0.169	0.249	0.361	0.533
2011	0.066	0.100	0.167	0.252	0.358	0.539
2012	0.066	0.102	0.166	0.255	0.355	0.547
2013	0.066	0.104	0.165	0.260	0.353	0.556
2014	0.066	0.106	0.164	0.264	0.352	0.566
2015	0.066	0.109	0.164	0.269	0.351	0.577
2016	0.066	0.111	0.164	0.275	0.350	0.589
2017	0.066	0.113	0.163	0.280	0.350	0.601
2018	0.066	0.116	0.164	0.287	0.350	0.614
2019	0.066	0.119	0.164	0.293	0.351	0.627
2020	0.066	0.121	0.164	0.299	0.351	0.641
2021	0.066	0.124	0.164	0.306	0.351	0.656
2022	0.067	0.127	0.164	0.314	0.352	0.672
2023	0.067	0.130	0.165	0.322	0.354	0.689
2024	0.067	0.134	0.166	0.330	0.355	0.707
2025	0.067	0.137	0.166	0.338	0.356	0.725
2026	0.068	0.141	0.167	0.347	0.358	0.744
2027	0.068	0.145	0.168	0.357	0.359	0.764
2028	0.068	0.148	0.169	0.366	0.361	0.785
2029	0.069	0.153	0.169	0.377	0.363	0.807
2030	0.069	0.157	0.170	0.387	0.365	0.829
2031	0.069	0.161	0.171	0.397	0.367	0.852
2032	0.070	0.165	0.172	0.408	0.368	0.875
2033	0.070	0.170	0.173	0.420	0.370	0.900
2034	0.070	0.175	0.174	0.432	0.372	0.925
2035	0.071	0.180	0.175	0.444	0.375	0.953

Figure 13. Gross State Product Impact Scenario 3 with 15 percent of Consumption Generated by Renewable Sources: Billions of Chain-weighted 1992 Dollars.



Comparing Scenarios 1, 2, and 3

Figures 14 and 15 compare the economic impacts, in terms of employment and GSP, of the three different scenarios. As the state's dependence on renewable energy increases, in terms of percent of total consumption generated from renewable sources, the employment and GSP impacts increase in a linear fashion. This relationship reflects in large part, the underlying model assumptions. Nevertheless, the results make clear the idea that there can be significant benefits to the state, including additional jobs and a larger volume of economic activity, if the conversion to renewable energy continues.

The largest economic effects are observed at the highest level of renewable energy dependence. When 15 percent of electric needs come from renewable energy generated within the state, over 5,000 jobs can be attributed to the renewable energy industry. Even lower levels of use have significant impact. More than 2,500 jobs result when 7 percent of generation needs arise from renewable sources.

Economic activity, in terms of energy production and expenditures, facilitates other economic activity. The direct economic effects are measured in terms of expenditures. These expenditures create secondary economic activity as firms producing energy increase purchases to their suppliers and employees demand homes, services, and retail goods in their community. Thus, the initial expenditures are multiplied in terms of

Figure 14. Employment Impact Comparisons: Scenarios 1, 2, and 3: Thousands of Jobs In Nevada Created in Nevada.

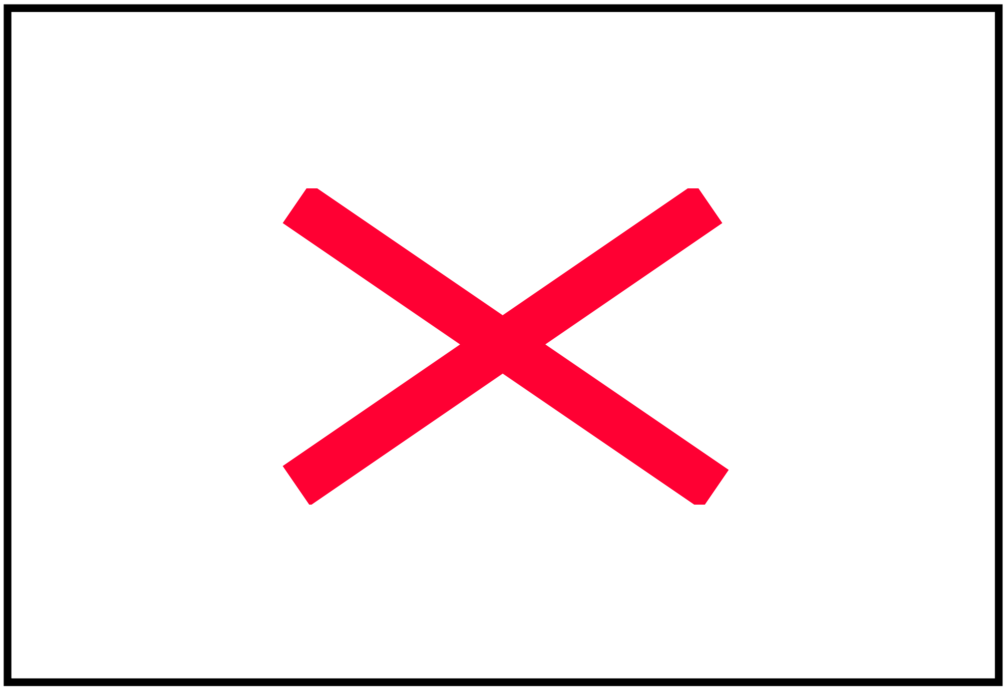


Figure 15. Gross State Comparisons: Scenarios 1, 2, and 3: Billions of Chain-weighted 1992 Dollars.

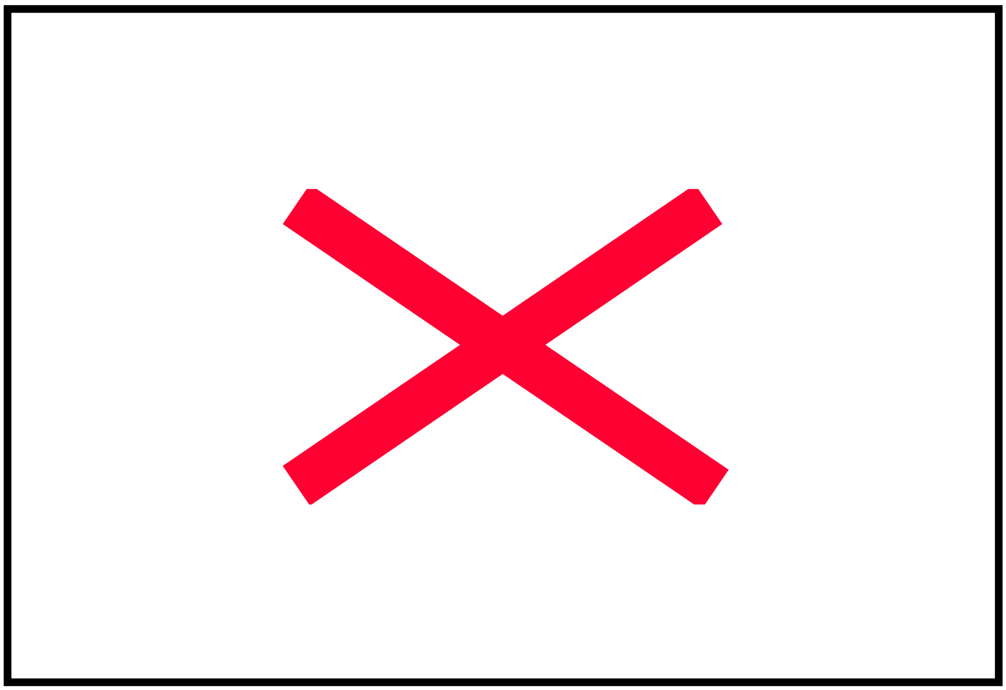


Table 6. Gross State Product Multipliers Under the Three Renewable Energy Use Scenarios: 2003 - 2035

Year	Current Use 3.9% of total consumption	Low Use 7% of total consumption	High Use 15% of total consumption
2003	1.94	2.09	2.09
2004	1.89	2.05	2.05
2005	1.86	2.00	2.00
2006	1.83	1.95	1.95
2007	1.80	1.91	1.91
2008	1.78	1.87	1.87
2009	1.77	1.84	1.84
2010	1.75	1.81	1.81
2011	1.73	1.79	1.79
2012	1.72	1.77	1.77
2013	1.70	1.75	1.75
2014	1.69	1.73	1.73
2015	1.68	1.72	1.72
2016	1.67	1.70	1.70
2017	1.66	1.69	1.69
2018	1.65	1.68	1.68
2019	1.64	1.67	1.67
2020	1.63	1.66	1.66
2021	1.62	1.65	1.65
2022	1.62	1.64	1.64
2023	1.61	1.64	1.64
2024	1.60	1.63	1.63
2025	1.59	1.62	1.62
2026	1.59	1.62	1.62
2027	1.58	1.61	1.61
2028	1.58	1.60	1.60
2029	1.57	1.60	1.60
2030	1.56	1.59	1.59
2031	1.56	1.58	1.58
2032	1.55	1.58	1.58
2033	1.55	1.57	1.57
2034	1.54	1.57	1.57
2035	1.54	1.56	1.56

economic impact. Table 6 compares the gross state product multipliers for the three different renewable energy resource use scenarios. A multiplier of 2 means that for every dollar of expenditure, two dollars of economic activity are generated when all rounds of economic activity have been completed. In each scenario, multipliers are highest initially as new dollars entering the economy broaden the economic base. The multipliers falls off modestly as the initial burst of economic activity is subsumed into the whole economy. On average, the multiplier is the highest for the low and high use scenarios, both having annual average multiplier gross state product multipliers of 1.72. The average annual multiplier for the current use scenario is slightly lower at 1.67. Nevertheless, the multipliers show that substantial indirect economic activity is generated by switching to in-state renewable energy generation.

VI. Conclusion

This report provides a preliminary assessment of the potential for renewable resources as a source of electricity and other energy in Nevada. We provide an overview of the existing stock of four primary renewable energy sources in the state: solar, wind, biomass, and geothermal. Using data from the DOE/EERE, we compile information on the current capacity for energy from renewable sources in the state. The data support the conclusion that Nevada has rich renewable fuel resources. Because of the state's unique geology and terrain, solar and wind power offer vast opportunities for development. Nevada also has one of the largest concentrations of geothermal resources in the nation. Its biomass potential is rated "fair" by the DOE. In the end, Nevada is one of the nation's leaders in the potential for renewable energy development.

We also offer a cost comparison for different fuel sources. Relative energy costs, in terms of levelized prices reflecting capital, labor, and input, suggest that renewable fuels are quickly gaining ground compared to conventional nonrenewable fuels. When environmental costs are considered, renewable fuels may be even more appealing.

The final section of the report compares three levels of dependence on renewable sources. Under Scenario 1, 3.9 percent of Nevada's current electricity consumption is generated by renewable sources within the state. Generation costs are modeled using average levelized costs of electricity generation by source. Total electric expenditures on electricity derived from renewable sources are used in the REMI model to assess economic impacts in the form of employment and GSP. The same methodology is used to assess the economic impact of two higher level of renewable dependence: Scenario 2 corresponding to 7 percent of total demand generated from renewable sources and Scenario 3 representing15 percent of electricity generated from renewable sources.

The REMI model results reveal that shifting to renewable resources will result in significant economic development within the state of Nevada. Currently, about 850 jobs may be either directly or indirectly attributable to electricity generation using renewable sources within the state. If Nevada continues to generate 3.9 percent of its current consumption using renewable energy, it can expect annual employment impacts ranging from the current level of 850 jobs to a low of 730 jobs. GSP impacts are considerable, even at the current energy usage. The model estimates that at present $70 million of GSP, in terms of chain-weighted 1992 dollars, arises either directly or indirectly from electricity generation using renewable sources.

A shift to more reliance on renewable sources, as required by the Nevada RPS, will boost employment and economic activity within the state. Assuming Nevada resources are used, increasing its renewable generation quota to 7 percent of total consumption will lead to between 1,900 and 2,549 jobs in the state. Annual gross state product impacts will range from $175 to $191 million in1992 dollars.

Employment and GSP impacts double when renewable energy generation reaches 15 percent of total consumption, the maximum required by the Nevada RPS. Annual employment impacts range from 4,000 to 5,500 jobs. GSP also receives a significant boost. In terms of chain-weighted 1992 dollars, between $375 and $409 million of economic activity will result from this level of dependence on renewable energy sources.

The model results show clear economic benefits in terms of GSP and new employment in the state of Nevada from electricity generation using renewable resources. It is important to note that this economic development supports sustainable growth within the state. Coal-fire generation has environmental costs in terms of degrading air quality and potential for supporting global warming. Similarly, petroleum and natural-gas generation are associated with varied environmental impacts, most notable global warming. Renewable energy generation, on average, is associated with less environmental degradation. Air-quality impacts are scant or nonexistent. And, save for electricity generation using biomass, renewable sources do not contribute to global warming because fossil fuels are not used. Thus, tallying the economic and environmental benefits of electricity energy generation, it’s clear that it could be an important contributor to sustainable economic development.

Another factor to consider is the regional economic development potential of electricity generation using renewable sources in rural areas. Much of rural Nevada is awash in geothermal, solar, and wind resources. Developing these resources in rural counties can concentrate the economic benefits where they are most needed. New jobs in the relatively highly paid utility industry could provide a core of income for counties that are fast losing traditional income sources such as mining.